Series 540
Cartridge Tape Drive
Product Description

SCSI-1 INTERFACE ADDENDUM

cipher®
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SECTION 1

GENERAL DESCRIPTION

INTRODUCTION

The intelligent tape drives provide the low-cost solution to backing up the smaller rigid disk drives. The drive is designed with two microprocessor controlled pcbs: the formatter and the basic tape drive board.

MICROPROCESSOR-CONTROLLED FORMATTER

The formatter board performs these functions:

- o SCSI 1 interfacing
- o QIC-24 block formatting
- o Reading status
- o Tape retension
- o Tape erasing
- o Tape writing
- o Tape reading

HOST INTERFACE CONTROL

A Z80B microprocessor controls the host interface and two 68-pin CMOS gate arrays. This microprocessor interprets host commands and input control lines; controls tape motion, track positioning, Write and Read sequences; and interprets the status of the basic drive. With output control and status lines, the microprocessor also controls data transfer to, and from, the host.

DATA TRANSFER CONTROL

The Buffer Management gate array (ADS 3570) at location U3 is the main component in data transfers between the host system and the "Basic Drive" interface gate array (ADS 4360) at location U23. During data transfer (either read or write) the buffer manager chip is the control device for the 16K x 9 cache buffer. The optional "Bus Parity" bit is also stored with the eight bit data in cache. The buffer manager is responsible for sequencing bytes of logical blocks (512 byte data block) in proper order and out of cache memory. Logical block sequencing is a function of the Z80B microprocessor. In the write mode data is first transferred by the "Buffer Manager" from the host to the cache memory, then when the "Write Buffer Threshold" is met, the "Buffer Manager" transfers byte wide data from cache to the "Basic Drive" gate array. The "Basic Drive" chip takes byte wide data from cache, along with the 4 byte block address from the microprocessor. The "Basic Drive" chip converts the data and address into a bit serial stream, calculates and appends the two CRC bytes to the data stream, and last, does a four to five bit GCR nibble conversion on the stream before supplying the final stream in real time to the basic drive. A read operation of tape is in essence a reverse of the previously mentioned operation.

SECTION 2

SCSI INTERFACING

INTRODUCTION

The SCSI interface on the drive is based on the ANSI Rev 17B SCSI standard for sequential devices. Optional features of the ANSI SCSI interface supported by the drive are:

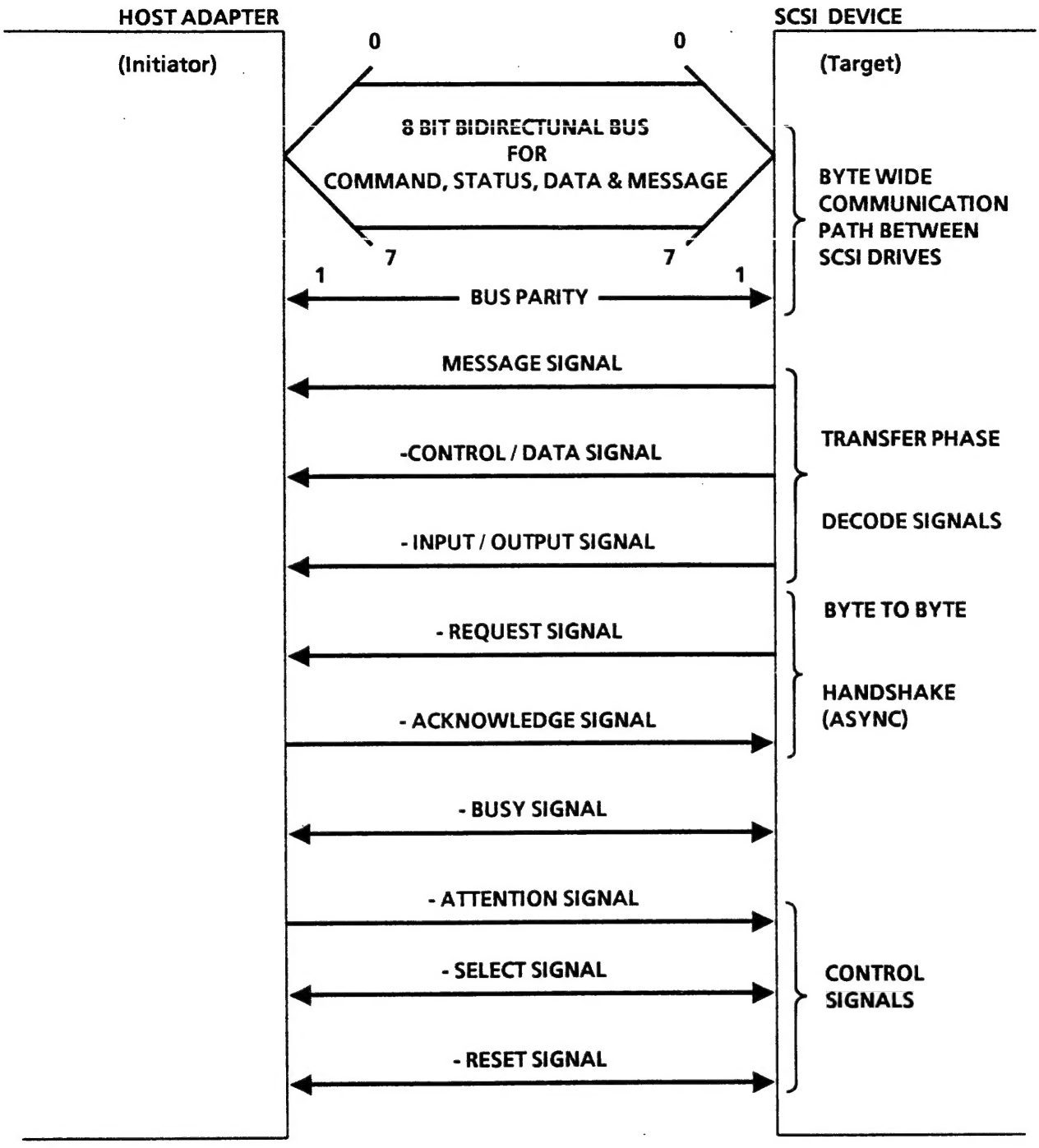
- o Optional bus parity
- o Disconnect/Reconnect
- o Optional SCSI bus termination power
- o Single ended signal drivers
- o Enhanced SCSI command set including copy command

The SCSI interface is composed of four groups of signals. They are:

- o Control signals(-Busy, -Attention, -Select and -Reset signals)
- o Transfer Phase decode signals (-Message, -C/D, -I/O)
- o Asynchronous byte to byte handshake signals (-Request, -Acknowledge).
- o Byte wide bus

A brief description of the signals by logical group follows. All signals are low active.

SCSI BUS



*1. Arrow Head implies signal destination (i.e. request to host)

2. Dual arrow-headed signals implies a wired or function or "signal in common" (i.e. reset signal)

SIGNAL DESCRIPTION

Control Signals

-RES (Reset) Input signal from the SCSI bus. When true (low) causes termination of any active operation being performed by the drive and a release of the SCSI bus.

-BSY (Busy) Bi-directional signal on the SCSI bus. Can be driven by any device on the SCSI bus indicating the bus is "occupied." When false (high) along with "select" false indicates that SCSI bus is available.

-SEL (Select) Bi-directional signal on the SCSI bus. Can be driven by any device on the SCSI bus. When true indicates the bus is in a selection or reselection phase.

-ATN (Attention) Input signal from the SCSI bus. When true during the selection or reselection phase indicates to the target SCSI device that the initiator has a message for the target.

Transfer Phase Decode Signals

-MSG (Message) Bi-directional signal on the SCSI bus. The message signal is driven by the SCSI target device that has control of the SCSI bus following the previous selection phase. When message is true (low) indicates that the current byte on the bus during the byte handshake is a message byte. The state of the "-I/O" signal indicates if it is a message from the initiator or to the initiator.

-I/O (Input/Output) Bi-directional signal on the SCSI bus. The -I/O signal is driven by the SCSI target device that has control of the SCSI bus following the selection phase. When the -I/O signal is true (low) indicates that the current byte on the bus during a byte handshake is an input byte from the target to the initiator. When the -I/O signal is false (high) indicates that the current byte is an output from the initiator to the target.

-C/D (Control/Data) Bi-directional signal on the SCSI bus. The -C/D signal is driven by the SCSI target device that has control of the SCSI bus following the selection phase. When the -C/D signal is true (low) indicates that the current byte on the bus during a byte handshake is a control byte (i.e. command, status, etc). The -C/D signal is false (high) indicates that the current byte on the bus is Data (i.e. R/W data, request sense data, mode select/sense data).

Asynchronous Byte To Byte Handshake Signals

-REQ (Request) Bi-directional signal on the SCSI bus. The -REQ signal is driven by the SCSI target device that has control of the SCSI bus following the selection phase. In an output operation the request signal indicates that the target is ready to accept a byte from the initiator. In an input operation the request signal indicates that the target has put an input byte on the bus and is waiting for the initiator to acknowledge it.

-ACK (Acknowledge) Bi-directional signal on the SCSI bus. The -ACK signal is

driven by the SCSI initiator device that has control of the SCSI bus following the selection phase. In an output operation the acknowledge signal indicates that the initiator has placed a byte on the bus in response to a target's -REQ. In an input operation the -ACK signal indicates that the initiator has latched the input byte from the target in response to the request signal.

Byte Wide Bi-directional Bus

DBO-DB7 (Data Bus) Byte wide bi-directional bus used to transfer commands, status, messages and data one byte at a time. Following the selection phase the selected target has full control of the bus.

PROTOCOL INTERFACING

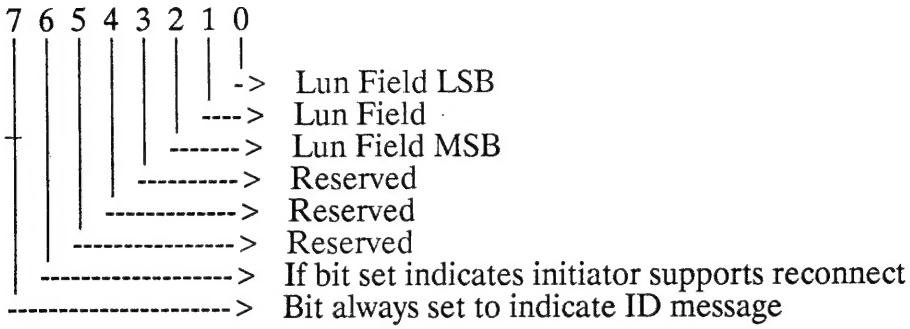
As mentioned earlier the drive isbased on the ANSI SCSI Rev. 17B. This compliance also includes the Standard SCSI Protocol Environment for:

1. Single initiator, single target non-arbitrating systems.
2. Single initiator, multiple target non-arbitrating system.
3. Single initiator, multiple target arbitrating system.
4. Multiple initiator, multiple target arbitrating system.

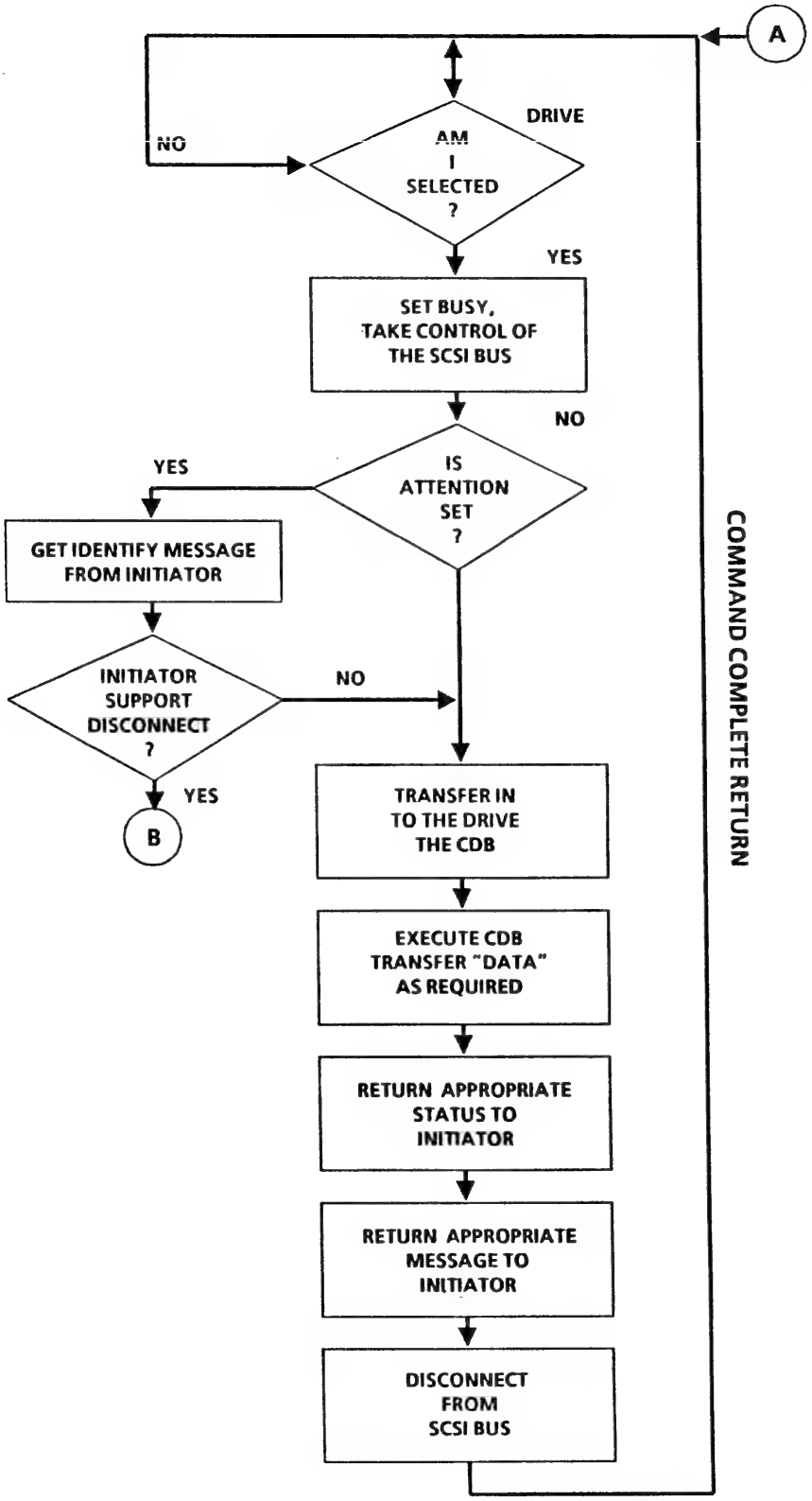
In addition the drive is fully compliant with, and supports the disconnect/reconnect function of SCSI. As host SCSI systems evolve the drive is ready to meet the needs of today's simple (single initiator, multiple target) and tomorrow's complex (multiple initiator, multiple target) SCSI systems. The drive's own on board intelligence is what allows the same drive to operate under different SCSI environments. The drive determines the type of SCSI environment it is in during the selection and transfer phase (a conceptual understanding of SCSI protocol, in general, can be found in the "Cipher SCSI Primer." If the initiator has the "Attention" line false during the selection phase to the drive, the drive will assume that it is in a non-reconnect environment (environment 1 & 2) and at no time will the drive disconnect from the SCSI bus until it has completed the commanded operation by returning the status byte and the command complete message. If the initiator has the attention signal true during the selection phase, the drive will "Request" a "Message Out" from the initiator as the first part of the transfer phase. The initiator must supply the "Identify" message back to the target in response to the "Request for Message Out." The drive will examine the "Identity" message from the Initiator to determine several operating parameters. They are:

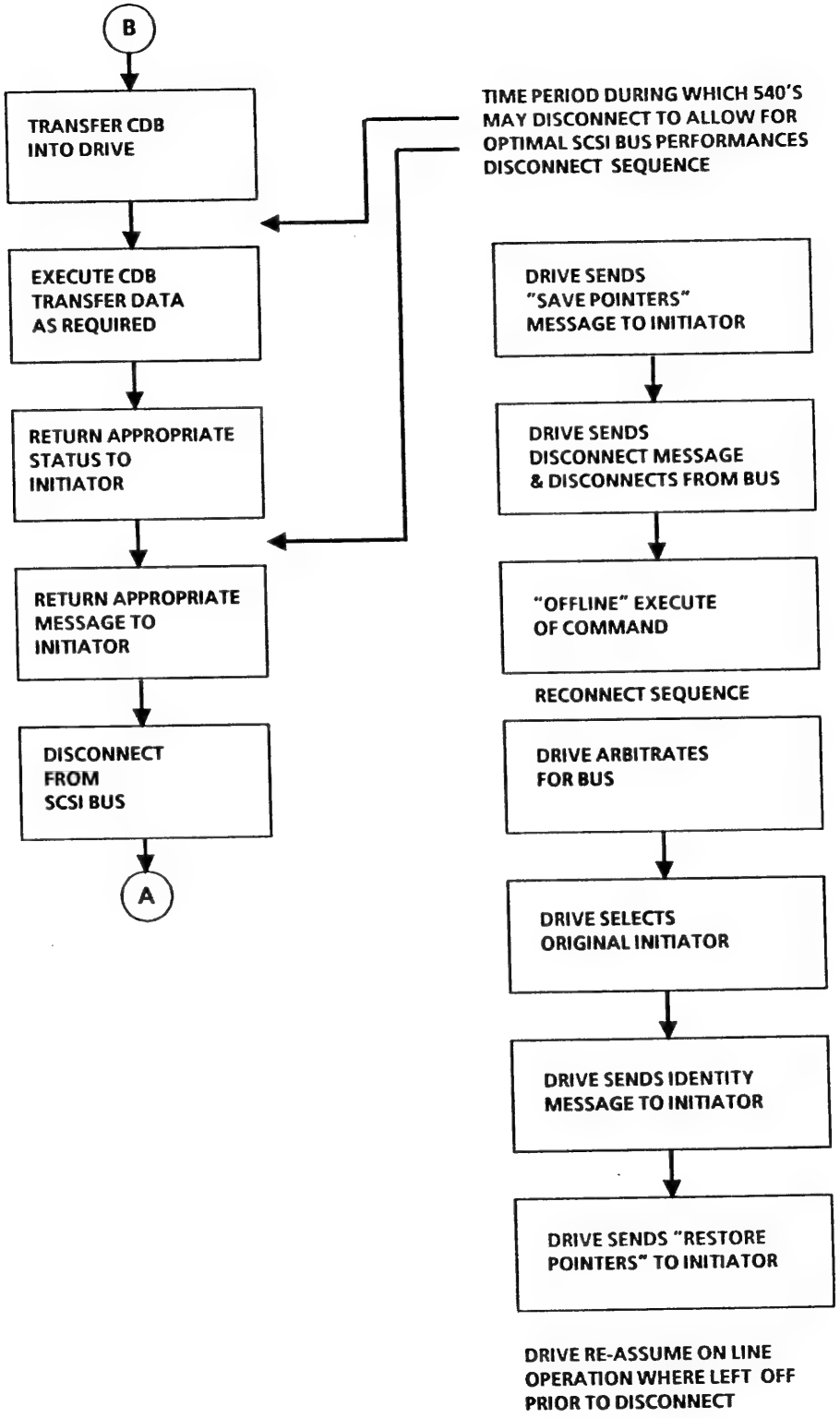
1. Does Initiator support Disconnect/Reconnect?
2. What logical unit does the Initiator want?

IDENTIFY MESSAGE FORMAT



PROTOCOL OPERATIONS IN BOTH ENVIRONMENTS




B
TRANSFER CDB INTO DRIVE
EXECUTE CDB TRANSFER DATA AS REQUIRED
RETURN APPROPRIATE STATUS TO INITIATOR
RETURN APPROPRIATE MESSAGE TO INITIATOR
DISCONNECT FROM SCSI BUS
A
TIME PERIOD DURING WHICH 540'S MAY DISCONNECT TO ALLOW FOR OPTIMAL SCSI BUS PERFORMANCES DISCONNECT SEQUENCE
DRIVE SENDS "SAVE POINTERS" MESSAGE TO INITIATOR
DRIVE SENDS DISCONNECT MESSAGE & DISCONNECTS FROM BUS
"OFFLINE" EXECUTE OF COMMAND
RECONNECT SEQUENCE
DRIVE ARBITRATES FOR BUS
DRIVE SELECTS ORIGINAL INITIATOR
DRIVE SENDS IDENTITY MESSAGE TO INITIATOR
DRIVE SENDS "RESTORE POINTERS" TO INITIATOR
DRIVE RE-ASSUME ON LINE OPERATION WHERE LEFT OFF PRIOR TO DISCONNECT

Status Transfer Phase

The Status Transfer Phase occurs at the completion of execution of a CDB (Command Descriptor Block). The status byte informs the Initiator of completion information. The status bytes supported by the drive are as follows;

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
STATUS BYTE	0	0	0	STATUS CODE FIELD				

STATUS CODE FIELD					
BIT 4	BIT 3	BIT 2	BIT 1	BIT 0	
0	0	0	0	0	Good Status, Command Completed Successfully (00H)
0	0	0	1	0	Check Condition, Abnormal Command Termination (02H)
0	1	0	0	0	Busy (08H)
1	1	0	0	0	Reservation Conflict (18H)
0	0	0	0	1	Nonexistent LUN (01H)

Message Transfer Phase

A message transfer Phase may occur at any time following a selection or reselection phase. Messages are a bi-directional in the sense that they can be to the "target" or from the target. The messages supported by the drive are listed in the table below.

I=Initiator T=drive T1=target, copy command

CODE (HEX)	DIRECTION	DESCRIPTION
00	T>I	Command complete - Process complete or initiator involvement complete in immediate mode.
02	T>I	Save Data Pointers
03	T>I	Restore Data Pointers
04	T>I	Disconnect
05	I>T	Initiator Detected Error
06	I>T	Abort
07	I>T T>I T>T1	Message Reject
08	I>T	No Operation
09	I>T	Message Parity Error
0A	T>I	Linked Command Complete
0B	T>I	Linked Command With Flag Complete
0C	I>T	Bus Device Reset
80	I>T T>I	Identify
C0	I>T T>T1	Identify Disconnect Enabled

COMMAND SET

The drive implementation contains all "Standard" and some "Optional" commands for Sequential devices as per ANSI Rev 17B. They are logically grouped by functionality. The groupings are:

1) System Commands
2) Write Commands
3) Read Commands
4) Copy Command
5) Position Commands
6) Diagnostic Commands

The following table is a quick reference to all commands supported by the drive.

OP CODE	COMMAND NAME	PAGE#
	System Type Commands	
16	RESERVE UNIT	14
17	RELEASE UNIT	15
00	TEST UNIT READY	16
1E	PREVENT / ALLOW MEDIA CHANGE	17
06	SET READ / WRITE PARAMETERS	18
05	READ BLOCK LIMITS	20
03	REQUEST SENSE	22
12	INQUIRY	26
15	MODE SELECT	30
1A	MODE SENSE	33
1B	LOAD / UNLOAD	36
	Write Type Commands	
0A	WRITE DATA	37
10	WRITE FILE MARKS	38
	Read Type Commands	
08	READ DATA	39
13	VERIFY	42
	Copy Type Commands	
18	COPY	43
	Position Type Commands	
11	SPACE	48
19	ERASE	50
01	REWIND	51
	Diagnostic Commands	
14	RECOVER BUFFERED DATA	52
1D	SEND DIAGNOSTIC	53

Command Information Common To All Commands

The drive uses the standard ANSI format for all commands. The format used is a multiple byte "Packet" referred to as a "Command Descriptor Block" or "CDB" for short. The following is an example of a typical CDB. As you will note, the field structure is common to all commands, however the field meanings and values may vary from CDB to CDB. The command field meaning and values are outlined on the following pages for each specific command.

EXAMPLE COMMAND DESCRIPTOR BLOCK

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	GROUP CODE			COMMAND CODE				
byte 1	LUN		COMMAND DEPENDANT					
byte 2	COMMAND DEPENDANT							
byte 3	COMMAND DEPENDANT							
byte 4	COMMAND DEPENDANT							
byte 5	0	0	0	0	0	0	FLG	LNK

Group Code - The Group Code field is an ANSI standard field that defines what group of ANSI commands a particular command belongs to and the length of that command's CDB. All commands on the drive belong to the ANSI group 0 command set and have a CDB length of six bytes.

Command Code - The Command Code field defines the actual command and the meaning/value of the "Command Dependent" fields.

Logical Unit Number (LUN) - This field is used to specify the one of eight logical units (basic tape drives) attached to the drive formatter/controller. The drive supports only one Logical Unit (0), any attempt to access the other Logical Units will result in an aborted command with return Status byte value of 01H indicating the Initiator attempted to access a nonexistent LUN.

The LUN field in a CDB will be overridden by the LUN field in the Identify message if the Initiator utilizes the Attention/Identify sequence during the selection phase. Again, the only valid value of this LUN field is 0H.

Command Dependent Fields - See specific command for details on meaning or values.

Link bit (LNK) - The Link bit is used to "Link" multiple commands together. If the LNK bit is set the drive will not disconnect from SCSI bus at the completion of the linked command, but instead go immediately to a command transfer for the next command.

Flag bit (FLG) - The flag bit is used in conjunction with the Link bit (LNK) to send "Intermediate Message with Flag" message to the Initiator.

Disconnecting During Command Exection

The drive does support the Disconnect/Reconnect feature of the SCSI bus. This feature can be enabled through the "Identify" message from the Initiator. The Identify message is transferred to the drive immediately following the Selection Phase if the Initiator had the Attention line true during the selection phase. Not all commands of the drive will disconnect during execution, those that can have been noted in the following command specific sections.

RESERVE UNIT COMMAND 16H

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	1	0	1	1	0
byte 1	0	0	0	THP	3RD PARTY ID			0
byte 2	0	0	0	0	0	0	0	0
byte 3	0	0	0	0	0	0	0	0
byte 4	0	0	0	0	0	0	0	0
byte 5	0	0	0	0	0	0	FLG	LNK

The Reserve Unit command causes the drive to reserve itself for the exclusive use of the Initiator who has just issued the command if the THP (Third Party Option) bit is false (zero). If the THP bit is true (one) then the drive reserves itself for the SCSI device specified by the Third Party ID field. The drive will remain "Reserved" until released by the original reserving Initiator. If an other Initiator

attempts to access the drive while it is reserved, the drive will return a "Reservation Conflict" status byte. The drive will not disconnect during the execution of this command.

RELEASE UNIT COMMAND 17H

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	1	0	1	1	1
byte 1	0	0	0	THP	3RD PARTY ID			0
byte 2	0	0	0	0	0	0	0	0
byte 3	0	0	0	0	0	0	0	0
byte 4	0	0	0	0	0	0	0	0
byte 5	0	0	0	0	0	0	FLG	LNK

The Release Unit command unlocks the drive from the "Reserved" state condition caused by a previous Reserved Unit command from the same Initiator. No error will occur if an Initiator attempts to "Release" a non-reserved drive. The drive will not disconnect during execution of this command.

TEST UNIT READY COMMAND 00H

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	0	0	0	0	0
byte 1	0	0	0	0	0	0	0	0
byte 2	0	0	0	0	0	0	0	0
byte 3	0	0	0	0	0	0	0	0
byte 4	0	0	0	0	0	0	0	0
byte 5	0	0	0	0	0	0	FLG	LNK

The Test Unit Ready command is used to verify the operational readiness of the drive. In order for the drive to return good status at the completion of the Test Unit Ready command, the following parameters must be met:

1) The drive must be powered on.

2) A tape cartridge must be in place in the drive.

3) No command is under execution by the drive.

4) The drive is not reserved by another Initiator.

The drive will not disconnect during execution of this command.

PREVENT/ALLOW MEDIUM REMOVAL 1EH

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	1	1	1	1	0
byte 1	0	0	0	0	0	0	0	0
byte 2	0	0	0	0	0	0	0	0
byte 3	0	0	0	0	0	0	0	0
byte 4	0	0	0	0	0	0	0	PRV
byte 5	0	0	0	0	0	0	FLG	LNK

The Prevent/Allow Medium Removal command controls the functionality of the front panel LED. The front panel LED is the means in which the drive informs the operator when it is "SAFE" to remove the cartridge. If the PRV bit is set to a one, the LED will be illuminated, if PRV is zero, the LED will be extinguished. A hard reset or reset message will also extinguish the LED.

SET READ/WRITE PARAMETERS COMMAND 06H

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	0	0	1	1	0
byte 1	0	0	0	0	1	0	0	0
byte 2	MAXIMUM TRACK NUMBER							
byte 3	MAXIMUM TRANSFER SIZE							
byte 4	0	0	0	0	0	EXT	0	QIC
byte 5	0	0	0	0	0	0	0	0

The Set Read/Write Parrameters command is a vendor unique command that allows the Initiator to fine tune certain operating characteristics of the drive. The Initiator need not support this command to use the drive. The field definitions and use are as follows:

Maximum Track Number (byte 2, bits 7 - 0) - This field allows the Initiator to stipulate the number of tracks to be written to or read from the cartridge. The valid entries are:

00H = One Track
01H = Two Tracks
02H = Three Tracks
03H = Four Tracks
04H = Five Tracks
05H = Six Tracks
06H = Seven Tracks
07H = Eight Tracks
08H = Nine Tracks

Since the drive is a nine track tape device, the power-up default value for the drive is nine tracks. In order to retain the nine track capability, this field should always be set to 08H when using this command.

Minimum Transfer Size (byte 3, bits 7 - 0) - This field can be used to tune the Transfer characteristics of the drive. The value in byte three is used to set the read/write buffer threshold. The following two examples will help to clarify the purpose of the Read/Write Buffer Threshold byte. Assume that this command has

already been passed with the R/W Buffer Threshold byte set to a value of 0CH (12 dec.), and the Initiator has enabled the drive disconnect/reconnect ability via the Identify message at the beginning of the Write command operation.

Write Mode - In the write mode the drive will disconnect from the Initiator when the drive's buffer is filled (approximately 32 blocks). The drive will remain disconnected until the drive has freed up space for 12 blocks in the buffer by fixing the previous data to tape. At that time the drive will reconnect for additional data.

Read Mode - In the read mode the drive will remain disconnected following the Read CDB transfer or previous data transfer until the drive has filled its buffer with twelve blocks from tape. At that time the drive will reconnect and transfer the read data to the initiator.

It should be noted that the R/W Buffer Threshold byte does not tell the drive the number of blocks to read or write, instead the value of this byte is used to tune the drive's buffer manager logic to the Initiators requirements. The allowable values for this byte are from 1 to 31. If the Initiator should attempt to set this value to a number outside the range supported by the drive, the drive will respond with a Check Condition status and an Illegal Request sense key when the Request Sense command is executed in response to the Check Condition status. The default value following power up is set to twelve.

QIC Media Bit (byte 4, bit 0) - The QIC bit is used to tell the drive the type of format to try and read. If this bit is set to a one, the drive will attempt to read data in a QIC 11 format. If the QIC bit is zero, the drive will attempt to read in the QIC 24 format mode. The power up default value of the drive is QIC 24.

Extended Write Mode (byte 4, bit 2) - The EXT bit is used to put the drive in the Extended Write Mode form of operation. In this mode of operation the drive will automatically rewrite the last block in the data buffer up to 48 times in an attempt to avoid a reposition. In effect, the drive will stall off a write reposition cycle for up to 240 ms by rewriting the last block up to 48 times prior to entering a Write Underrun condition. The default condition on power up or reset is the non-extended mode of operation.

READ BLOCK LIMITS COMMAND 05H

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	0	0	1	0	1
byte 1	0	0	0	0	0	0	0	0
byte 2	0	0	0	0	0	0	0	0
byte 3	0	0	0	0	0	0	0	0
byte 4	0	0	0	0	0	0	0	0

The Read Block Limits command is used to find the block size from the drive. Since the drive deals only with a fixed block length of 512 bytes, the drive will always return the same value for both Maximum and Minimum Block Lengths values. The following is an example of the return data supplied by the drive in response to the Read Block Limits command.

RETURN DATA READ BLOCK LIMITS COMMAND

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	0	0	0	0	0
byte 1	MAXIMUM BLOCK LENGTH (MSB) 00H							
byte 2	MAXIMUM BLOCK LENGTH 02H							
byte 3	MAXIMUM BLOCK LENGTH (LSB) 00H							
byte 4	MAXIMUM BLOCK LENGTH (MSB) 02H							
byte 5	MAXIMUM BLOCK LENGTH (LSB) 00H							

The above data is returned to the Initiator during the Data In phase of the Read Block Limits command.

REQUEST SENSE COMMAND 03H

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	0	0	0	1	1
byte 1	0	0	0	0	0	0	0	0
byte 2	0	0	0	0	0	0	0	0
byte 3	0	0	0	0	0	0	0	0
byte 4	NUMBER OF REQUESTED SENSE BYTES							
byte 5	0	0	0	0	0	0	FLG	LNK

The Request Sense command is intended for interrogating the drive when the Initiator has received a Check Condition status byte from the drive on a previous command. The returned Sense Data has two basic formats, Standard and Extended. An Initiator selects which format of returned Sense Data it wants through byte 4 of the Request Sense CDB. A value of 0 - 4 in byte 4 (Number of Request Sense Bytes) will return the Standard Sense byte format. A Request Sense Byte count of 5 or more will return sense data in the Extended Data format. A Request Sense Byte count of 11 (0BH)will return the full Extended Request Sense Data

STANDARD REQUEST SENSE DATA FORMAT

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	VAD		ERCL		ERCD			
byte 1	0	0	0	SENSE INFORMATION (MSB)				
byte 2	SENSE INFORMATION							
byte 3	SENSE INFORMATION (LSB)							

The Extended Request Sense Data format and field definitions follow.

EXTENDED REQUEST SENSE DATA FORMAT(NON-COPY)

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	AVF	1	1	1	0	0	0	0
byte 1	SEGMENT NUMBER							
byte 2	FM	EOM	0	0	SENSE KEY			
byte 3	SENSE INFORMATION BYTE (MSB)							
byte 4	SENSE INFORMATION BYTE							
byte 5	SENSE INFORMATION BYTE							
byte 6	SENSE INFORMATION BYTE (LSB)							
byte 7	ADDITIONAL SENSE LENGTH							
byte 8	ERCL				ERCD			
byte 9	NUMBER OF RECOVERABLE ERRORS (MSB)							
byte 10	NUMBER OF RECOVERABLE ERRORS (LSB)							

Field definitions for both the Standard and Extended Request Sense Data format follow. The heading line for each field will define which format uses the field, in some cases the field will be used by both formats, this will also be noted.

AVF - Address Valid Flag (Standard & Extended) - This bit when on, indicates that the Sense Information Bytes specify a residue count (the difference) from the requested number of blocks to the actual number of blocks accessed.

Sense Information Bytes - (Standard & Extended) - The Sense Information Bytes specify a residue count (the difference) from the requested number of blocks to

the actual number of blocks accessed.

FM - File Mark - (Standard and Extended) - Current command encountered a file mark while processing.

EOM - End Of Media (Standard and Extended) - Current command encountered End Of Tape condition.

ERCL - Error Class (Standard & Extended) - The Error Class Field (bits 4-6) indicate the source of the error. The field values are defined as follows:

BITS 06-05-04	ERROR CLASS DEFINITION
0 0 0	Drive Error
0 0 1	Controller/Formatter Error
0 1 0	System Related Error
0 1 1	Vendor Unique Error

ERCD - Error Code (Standard & Extended) - The Error Code bits define the type of error that has occurred. The Error Class in conjunction with the Error code fully defines the type of error. The table below defines the conjunctive error meaning.

CONJUNCTIVE ERCL ERCD DEFINITIONS

BITS ERCL 06 -	05 -	04 -	ERCD 03 -	02 -	01 -	00	ERROR DEFINITION	
				Basic Drive Errors				
0	0	0	0	0	0	0	No Sense	(00H)
0	0	0	0	1	0		Motor Stall Write	(02H)
0	0	0	0	I	0	0	Motor Stall Read	(04H)
0	0	0	1	0	0	1	Media Not Loaded	(09H)
0	0	0	1	0	1	0	Insufficent Capacity	(0AH)
0	0	0	1	0	1	1	Drive Timeout	(0BH)
				Controller/Formatter Errors				
0	0	1	0	0	0	1	Uncorrectable Errors	(11H)
0	0	1	0	1	0	0	Block Not Found	(14H)
0	0	1	0	1	1	0	DMA Time Out Error	(16H)
0	0	1	0	1	1	1	Write Protected	(17H)
0	0	1	1	0	0	0	Correctable Error	(18H)
0	0	1	1	0	0	1	Bad Block Found	(19H)
0	0	1	1	1	0	0	File Mark Detected	(1CH)
0	0	1	1	1	0	1	Compare Error On Verify	(1DH)
				System Related Errors				
0	1	0	0	0	0	0	Invalid Command	(20H)
				Vendor Unique Errors				
0	1	1	0	0	0	0	Media Change or Bus Device Reset	(30H)
0	1	1	0	0	0	1	Command Time Out	(31H)
0	1	1	0	0	1	1	Append Error	(33H)
0	1	1	0	1	0	0	Read End Of Media	(34H)

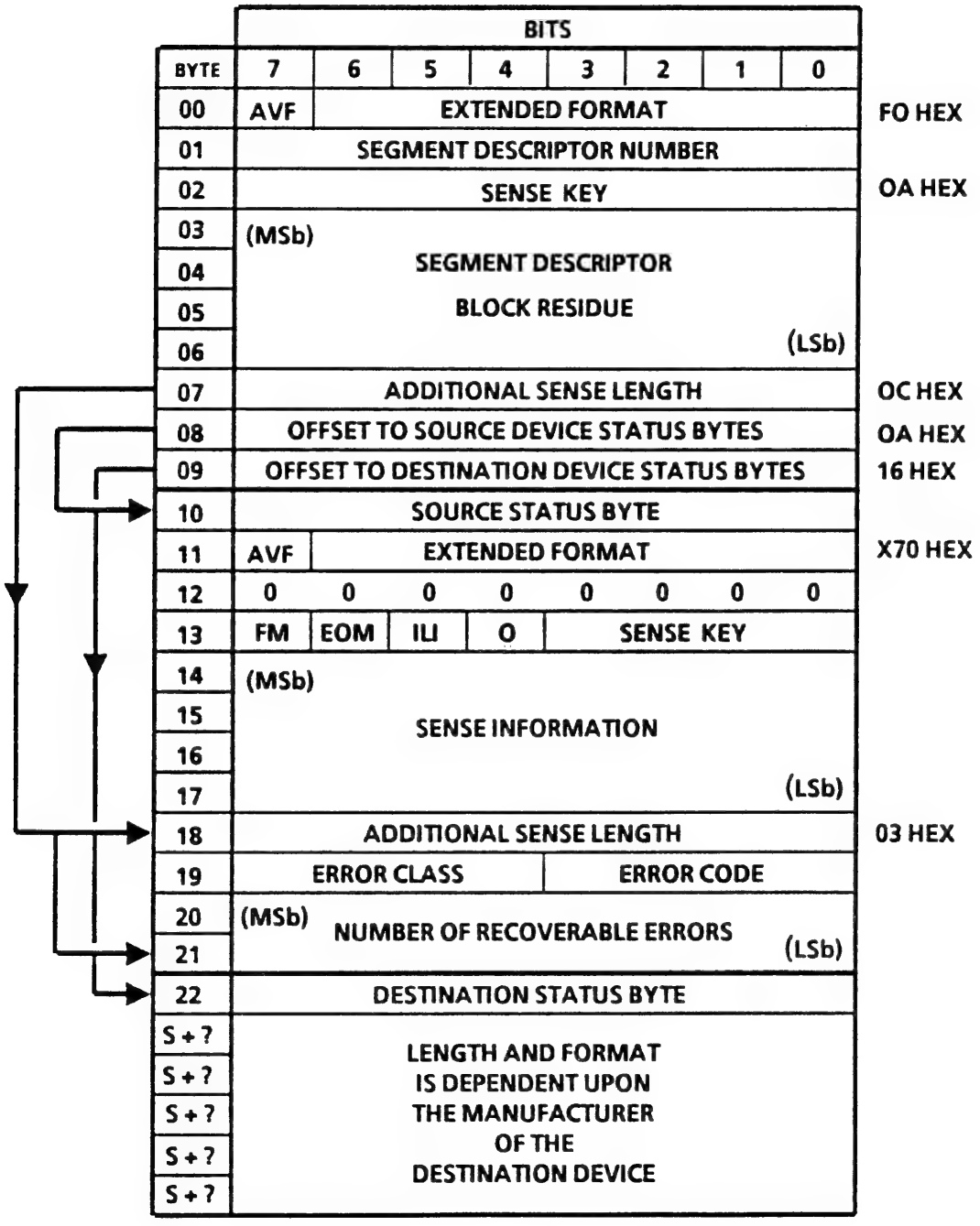
Sense Key - (Extended Format Only)
The Sense Key nibble is an ANSI compatible error code field. The follow table outlines the definitions for each nibble that may appear in the Sense Key field. An Initiator/Host system should use the Sense Key as the "Primary" key to define the "Check Condition" situation.

SENSE KEY INTERPRETATION

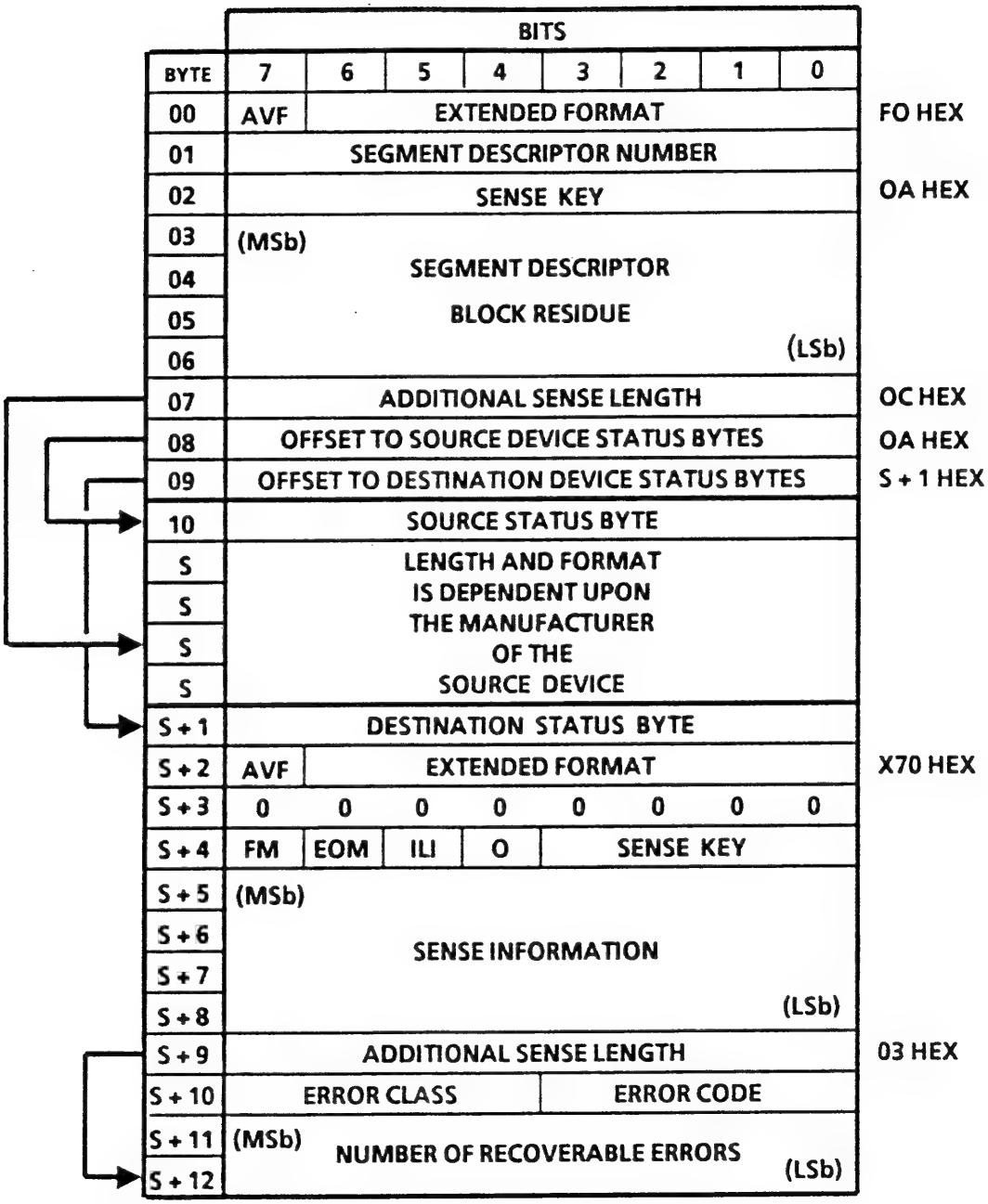
HEX CODE	ERROR CONDITION
00	No Sense
01	Recoverable Error, The Last Command Completed Successfully with Recovery Action.
02	Not Ready, Operator Intervention May be Required.
03	Media Error, Command Terminated with a Hard Error.
04	Hardware Error, Non-recoverable Hardware Error has Occurred.
05	Illegal Request.
06	Unit Attention, Media Change or SCSI Bus Device Reset has been issued to the drive.
07	Write Protected.
08	Blank Check, drive has Encountered Erased tape.
09	Vendor unique, error code and error class contain additional information.
0A	Copy Aborted.
0B	Command Aborted.
0C	Reserved.
0D	Volume overflow, drive has hit EOM & Data still remains in buffer.
0E	Verify miscompare, data on tape did not match source data.
0F	Reserved.

Request Sense Command

The following is the Return Data Format for the Request Sense Command when a Copy Command has aborted and the drive is the source device for the Copy Command. Whenever a system (Initiator) receives a "check condition" status byte on a copy command the responding "Request Sense" command should set its allocation length in the CDB to 22 hex (33DEC) to recover all possible sense information.



Request Sense Command (cont.)
The following is the Return Sense Data Format for the drive when a Copy Command was aborted and the drive was the "Destination" device for the copy.



INQUIRY COMMAND (12H)

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	1	0	0	1	0
byte 1	0	0	0	0	0	0	0	0
byte 2	0	0	0	0	0	0	0	0
byte 3	0	0	0	0	0	0	0	0
byte 4	NUMBER OF INQUIRY BYTES TO TRANSFER							
byte 5	0	0	0	0	0	0	FLG	LNK

Number Of Inquiry Bytes To Transfer - This byte specifies the number of Inquiry bytes the drive is to transfer to the Initiator. The valid range for this field is 0-5. The format of the returned Inquiry data is shown in the table below.

INQUIRY DATA FORMAT

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	0	0	0	0	DTYP
byte 1	RMV	0	0	0	0	0	0	0
byte 2	0	0	0	0	0	0	VERSION	
byte 3	0	0	0	0	0	0	0	0
byte 4	0	0	0	0	0	0	0	0

Device Type (DTYP) - The Device Type bit is set to a 1 to indicate a sequential device as per ANSI.

Removable Media (RMV) - The Removable Media bit is set to a 1 indicating that the cartridge is removable.

Version - The Version field is set to a 1 indicating compliance to the ANSI SCSI standard.

Length Of Additional Bytes (byte 4) - Byte four is zeroed out to indicate that there are no additional bytes to be transferred.

MODE SELECT COMMAND 15H

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	1	0	1	0	1
byte 1	0	0	0	0	0	0	0	0
byte 2	0	0	0	0	0	0	0	0
byte 3	0	0	0	0	0	0	0	0
byte 4	0	0	0	0	PARAMETER LIST LENGTH			
byte 5	0	0	0	0	0	0	FLG	LNK

The Mode Select command is the mechanism that enables an Initiator to pass device parameters to the drive. The drive will not disconnect from the Initiator while executing this command.

Parameter List Length - The Parameter List Length field defines the number of parameter bytes that will be transferred to the drive during the Data Out phase. The Parameter list has three components they are:

1) Parameter List Header (4 bytes)
2) Parameter Block Descriptor (8 bytes)
3) Vendor Unique Parameter byte (1 byte)

The Parameter List byte format is listed on the following pages.

Mode Select Parameter List Format
MODE SELECT PARAMETER LIST HEADER

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	0	0	0	0	0
byte 1	0	0	0	0	0	0	0	0
byte 2	0	0	0	BUF	0	0	0	0
byte 3	DESCRIPTOR LENGTH							
	MODE SELECT DESCRIPTOR BLOCK							
byte 4	DENSITY CODE							
byte 5	NUMBER OF BLOCKS (MSB)							
byte 6	NUMBER OF BLOCKS							
byte 7	NUMBER OF BLOCKS (LSB)							
byte 8	0	0	0	0	0	0	0	0
byte 9	BLOCK SIZE (MSB)							
byte 10	BLOCK SIZE							
byte 11	BLOCK SIZE (LSB)							
	VENDOR UNIQUE PARAMETER BYTE							
byte 12	0	0	0	0	0	DEA	AUI	SEC

Buffer Mode (BUF) - The Buffered Mode bit is used to control the Status reporting procedure of the drive. If the BUF bit is set to a one, the drive will report status prior to the physical completion of a Write or Verify command. If the BUF bit is set to a zero, the drive will not report status until all data is fixed to tape (Write) or until all data is read checked (Verify). The power-up default value for the drive is the buffered mode.

Descriptor Length - The Descriptor Length field specifies the number of Descriptor bytes to transfer as part of the Mode Select Parameter list. The valid entries for this field are 0 (no Descriptor bytes) and 8 (all Descriptor bytes).

Density Code - The Density Code byte defines the format to read or write from the media. The following table are the valid entries for the density byte.

00H - QIC 24

05H - QIC 24 (Default Format)

04H - QIC 11 Four Track

84H - QIC 11 Nine Track

Number of Blocks - The Number of Blocks field is not supported by the drive and must be set to zero.

Block Size - The Block Size field is not supported by the drive and must be set to zero.

Vendor Unique Byte Mode Select Functions

Disable Erase Ahead (DEA) - The DEA bit when set causes the drive to not perform the QIC 24 standard Erase Ahead at the completion of a Write type operation. The Erased Gap is used to indicate the End of Recorded Media (ERM) in the Read mode. It is strongly recommended that the Initiator when completing the last Write Operation to a Cartridge always terminate the media with a Logical End of Recorded Media marker of double Filemarks.

Autoload Inhibit (AUI) - The Autoload Inhibit bit turns off the default Autoload function of the drive. The drive will Automatically position a newly inserted cartridge to the BOM (Beginning Of Media)without being commanded in the default mode. By setting the AUI bit to one, an initiator can disable this feature, but now must assume the responsibility of positioning the newly inserted cartridge to the BOM location prior to a read or write command.

Soft Error Count (SEC) - The Soft Error Count bit when set, will cause the drive to suppress a "Check condition" status that would normally be generated by a Soft Read or Write Error. The Accumulated Soft Error Count is still available through the Request Sense command.

MODE SENSE COMMAND 1AH

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	1	1	0	1	0
byte 1	0	0	0	0	0	0	0	0
byte 2	0	0	0	0	0	0	0	0
byte 3	0	0	0	0	0	0	0	0
byte 4	0	0	0	0	PARAMETER LIST LENGTH			
byte 5	0	0	0	0	0	0	FLG	LNK

The Mode Sense command is the mechanism that enables an Initiator to check device parameters of the drive. The drive will not disconnect from the Initiator while executing this command.

Parameter List Length - The Parameter List Length field defines the number of parameter bytes that will be transferred to the drive during the Data In phase. The Parameter list has three components. They are:

1) Parameter List Header (4 bytes)

2) Parameter Block Descriptor (8 bytes)

3) Vendor Unique Parameter byte (1 byte)

The Parameter List byte format is listed on the following pages.

Mode Sense Parameter List Format
MODE SENSE PARAMETER LIST HEADER

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	0	1	1	0	0
byte 1	MEDIA TYPE							
byte 2	WRP	0	0	BUF	0	0	SPD	
byte 3	DESCRIPTOR LENGTH							
	MODE SENSE DESCRIPTOR BLOCK							
byte 4	DENSITY CODE							
byte 5	NUMBER OF BLOCKS (MSB)							
byte 6	NUMBER OF BLOCKS							
byte 7	NUMBER OF BLOCKS (LSB)							
byte 8	0	0	0	0	0	0	0	0
byte 9	BLOCK SIZE (MSB)							
byte 10	BLOCK SIZE							
byte 11	BLOCK SIZE (LSB)							
	VENDOR UNIQUE PARAMETER BYTE							
byte 12	0	0	0	0	0	DEA	AUI	SEC

Media Type -The Media Type field is used to indicate the type of media that is currently load in the drive. The possible values for this field are as follows:

81H = 310 Orstead media (300ft, 450ft or 550ft)
80H = 550 Orstead media (600ft)

The drive uses this same information internally to automatically optimize its read and write chain for the particular type of media that is loaded.

Write Protect (WP) - The WP bit is used to indicate if the currently loaded media is Write Protected. If the WP bit is set to a one, the media is Write Protected.

Buffer Mode (BUF) - The Buffered Mode bit is used to indicate the Status reporting procedure of the drive. If the BUF bit is set to a one, the drive will report status prior to the physical completion of a Write or Verify command. If the BUF bit is set to a zero, the drive will not report status until all data is fixed to tape(Write) or until all data is read checked(Verify). The power up default value for the drive is the buffered mode.

Speed (SPD) - This field is used to indicate the Speed of the drive. These bits will always be set to a 1 0 binary to indicate a speed of 90 IPS.

Descriptor Length - The Descriptor Length field specifies the number of Descriptor bytes to transfer as part of the Mode Sense Parameter list. The valid entries for this field are 0 (no Descriptor bytes) and 8 (all Descriptor bytes).

Density Code - The Density Code byte defines the format to read or write from the media. The following table are the valid values for the density byte.

05H - QIC 24 (Default Format)
04H - QIC 11 Four Track
84H - QIC 11 Nine Track

Number of Blocks - The Number of Blocks field will contain one of two following values based on the media type field.

MEDIA TYPE = 80 = **01-D4-C0** (approx. 600 ft.)
MEDIA TYPE = 81 = **01-63-78** approx 450 ft.)

Block Size - The Block Size field will return a value of 0200H indicating a 512 byte block size.

Vendor Unique Byte Mode Sense Functions

Disable Erase Ahead (DEA) - When the DEA bit is set to a one, the drive automatic Erase Ahead function has been disabled by a previous Mode select command.

Autoload Inhibit (AUI) - The Autoload Inhibit bit indicates if the drive's autoload function has been disabled. If the AUI bit is one, a previous Mode Select command has disabled the Autoload feature of the drive.

Soft Error Count (SEC) - The Soft Error Count bit when set, indicates that the drive is currently suppressing the Check Condition status on commands that have SOFT errors during execution.

LOAD/UNLOAD COMMAND 1BH

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	1	1	0	1	1
byte 1	0	0	0	0	0	0	0	0
byte 2	0	0	0	0	0	0	0	0
byte 3	0	0	0	0	0	0	0	0
byte 4	0	0	0	0	0	0	RET	LD
byte 5	EOT	0	0	0	0	0	FLG	LNK

The Load/Unload CDB shown above, informs the drive how to position the currently inserted cartridge.

Retension (RET) - If the RET bit is set to a one the drive will perform a retension pass on the media before completing the Load or Unload operation.

Load (LD) - When the LD bit is set to a one, the drive will perform a Load operation on the media. The drive will illuminate the front panel LED, keep the Unsafe to Remove Media LED on until one of the following occur:

1) drive is given and completes an Unload command.

2) drive is an Allow media removal command.

End Of Tape - The EOT bit when set will cause an Unload command to position tape to an End of Tape location. This caused any future Load operation on the cartridge to also act as a "Mini Retension" pass.

WRITE DATA COMMAND 0AH

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	0	1	0	1	0
byte 1	0	0	0	0	0	0	0	FBM
byte 2	NUMBER OF BLOCKS TO TRANSFER (MSB)							
byte 3	NUMBER OF BLOCKS TO TRANSFER							
byte 4	NUMBER OF BLOCKS TO TRANSFER (LSB)							
byte 5	0	0	0	0	0	0	FLG	LNK

The Write command causes the number of blocks defined by the Number Of Blocks To Transfer field to be transferred from the Initiator to the drive where they are fixed to tape. The drive may disconnect during the execution of this command. Their are several ways in which a Write Command can terminate operation. They are:

1) Normal termination, all blocks transferred.

2) EOM termination, not all blocks transferred, blocks in drive buffer fixed to tape.

3) Volume Overflow, EOM encountered, not all blocks transferred, blocks remaining in drive buffer.

4) Error termination, Media or Drive error prevents normal termination.

Fixed Block Mode (FBM) - The FMB bit must be set to a one to avoid a Check Condition situation from occurring.

WRITE FILE MARKS (10H)

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	0	0	0	0	0
byte 1	0	0	0	0	0	0	0	0
byte 2	NUMBER OF FILE MARKS (MSB)							
byte 3	NUMBER OF FILE MARKS							
byte 4	NUMBER OF FILE MARKS (LSB)							
byte 5	0	IMED	0	0	0	0	FLG	LNK

The Write File Mark command causes one or more complete blocks of file marks to be written to tape, beginning at the logical current media position. The number of file mark blocks to be written is specified by the contents of the number of file marks (Bytes 02 through 04 of the CDB).

If the disconnect function is enabled, the drive may disconnect from the Initiator while executing this command.

Number of File Marks - These bytes specify the Number of file marks to be written on the drive. A zero value in these bytes indicates that no file mark blocks are to be written. If these bytes are equal to 0 and the IMED bit is equal to 0, the drive purges the cache of all data. If the purge operation was successful, the drive issues a Command Complete status code. If the purge operation was not successful, the drive issues a Check Condition status code and the number of blocks remaining in the cache (the residue) is indicated in the Sense Information bytes of the Request Sense command.

Immediate (IMED) - The Immediate bit is valid if the drive is in cache buffering mode set by the BUFM bit in the Mode Select CDB. If this vendor-unique bit (IMED bit) is set to 1, the drive terminates the Write File Mark command immediately. If BUFM bit is reset to 0, the command terminates only after all buffered data and the file marks have been written to tape. The IMED bit is also used for Write Synchronization operations. When the Number of File marks field equals 0, the IMED bit is reset to 0, the drive writes to tape the contents of the cache before it terminates the Write File Mark command.

READ COMMAND 03H

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	0	0	0	0	0
byte 1	0	0	0	0	0	0	0	FBM
byte 2	NUMBER OF BLOCKS TO TRANSFER (MSB)							
byte 3	NUMBER OF BLOCKS TO TRANSFER							
byte 4	NUMBER OF BLOCKS TO TRANSFER (LSB)							
byte 5	0	0	0	0	0	0	FLG	LNK

The Read CDB, shown above, causes data to be read from the drive and transferred to the Initiator. The amount of data transferred is a multiple of the block length (i.e., 512 data bytes/block). The Read command specifies the number of data blocks to be read. The Read command terminates when there is present one of the following conditions:

- o The number of data blocks to be read is transferred
- o A file Mark is encountered
- o The End-Of-Media is encountered
- o An unrecoverable read error occurs on a block

If a file mark is encountered during a Read command, the drive sends a Check Condition status code to the Initiator and sets the File Mark bit in the Extended Sense (Byte 02) to 1 and the Sense Key (in the Extended Sense Byte) to Good. The Valid Address bit in Extended Sense Byte is set to 1 and the Sense Information Bytes are set to the difference between the requested transfer length and the actual number of blocks successfully read. The non-extended Error Class and Code are set to File Mark Detected.

NOTE

If a recoverable error occurs on a file mark block, the drive returns a Sense key that only reflects that a file mark was detected.

If a logical EOM (which indicates a lack of data on a tape cartridge) is detected during a Read command, the drive sends a Check Condition status code to the Initiator and sets a Blank Check error code in the Extended Sense Byte. The Valid Address bit is set to 1 and the Sense Information Bytes are set to the difference between the requested transfer length and the actual number of blocks successfully read. The non-extended Error Class and Code are set to Read EOM.

If an unrecoverable error occurs during a read operation, the drive terminates the Read command and sends a Check Condition status code. It sets the AVF bit in the Extended Sense Byte to 1. The Sense Information Bytes contain the Residual Count (total number of blocks not read). The "Read Command Error Conditions" lists media-related or drive related errors which can occur during a read operation and their corresponding Sense Keys and Sense Code (Sense Keys and Sense Codes are listed in their hexadecimal values). If the physical end-of-tape (EOT) occurs during a Read command, the drive sends a Check Condition status code to the Initiator and sets the Sense Key in Extended Sense (byte 02) to No Sense with the EOM bit set to 1. The Valid Address bit is set to 1 and the Sense Information Bytes are set to the difference between the requested transfer length and the actual number of blocks successfully read. The drive does not require a file mark to be the absolute last block on a tape cartridge for an EOM condition to be detected. It is recommended that the host write a file mark as the last block and check that a file mark is the last block read during the execution of a READ command. This action ensures the drive did not miss the last block because an error condition occurred on the block.

If an additional Read command is issued after a read error occurs, the read operation begins on the block that follows the block where the error occurred.

The Soft Error Count (the number of recoverable errors) is cleared on the first Read command that is issued after a non-Read command has been executed.

If the Disconnect function is enabled, the drive may disconnect from the Initiator while executing this command.

READ Command Error Conditions

SENSE KEY	SENSE CODE	READ ERROR
BLANK CHECK (08)	READ EOM (34)	The drive detected a logical end-of-media condition.
ILLEGAL REQUEST (05)	READ EOM (34)A	Read command was issued after a Write command but no intervening rewind operation occurred.
ILLEGAL REQUEST (05)	INVALID COMMAND (20)	After a Verify command in the immediate mode was issued, a READ command was issued before the verify operation was completed.
NO SENSE (00)	FILE MARK (1C)	The drive detected a file mark. The FM bit in the Extended Sense Byte is set to 1.
NO SENSE (00)	READ EOM (34)	The drive detected a physical end-of-media

Fixed Block Mode (FBM) - The drive sends an Invalid Command error code if the Fixed Block Mode bit (byte 01, bit 00) in the Read command packet is not set to 1.

Number of Blocks to Transfer - These bytes specify the number of bytes the Initiator has allocated for the returned data. When this byte is 0, no data is transferred and the current position is not changed. This condition is not considered an error.

VERIFY COMMAND (13H)

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	1	0	0	1	1
byte 1	0	0	0	0	0	0	BC	1
byte 2	NUMBER OF BLOCKS TO VERIFY (MSB)							
byte 3	NUMBER OF BLOCKS TO VERIFY							
byte 4	NUMBER OF BLOCKS TO VERIFY (LSB)							
byte 5	0	IMED	0	0	0	0	FLG	LNK

The Verify command has two modes of operation. They are:

1) CRC read check against recorded CRC.
2) Byte to byte compare between initiator supplied data

If the disconnect feature is enabled, the drive may disconnect during the execution of this command.

Byte Compare (BC) - The BC field bit determines the mode of operation for the drive during the execution of the Verify command. If the BC bit is set to a zero, the drive will read check the previously written data against the CRC field that was written as part of the QIC-24 format. If the BC bit is a one, the drive will read check the previously written data against the data supplied by the Initiator.

Number of Blocks to Verify - The Number of Blocks to Verify field informs the drive the number of blocks to read check against the tapes CRC field when the BC field is set to a zero. If the BC field is set to a one, the Number of Blocks to Verify field serves two purposes. First it informs the drive the number of blocks it must read from tape, and second, it informs the drive of the number of blocks that must be transferred from the Initiator to compare against the data read from tape.

Immediate (IMED) - The Immediate field determines when the drive returns command completion status. If the IMED bit is set to a zero, the drive will return the status byte when all data has been verified. When the IMED bit is set to a one, when all Initiator supplied data has been transferred to the drive for the byte to byte compare.

COPY COMMAND (18H)

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	0	0	0	0	0
byte 1	0	0	0	0	0	0	0	0
byte 2	PARAMETER LIST LENGTH (MSB)							
byte 3	PARAMETER LIST LENGTH							
byte 4	PARAMETER LIST LENGTH (LSB)							
byte 5	0	0	0	0	0	0	FLG	LNK

NOTE

The initiator must support disconnect/reconnect and notify the drive via the identify message, otherwise the copy command will be aborted.

The drive offers two different modes of copy capability they are:

1) Drive is copy Manager and Target of the Copy data from another SCSI device.
2) Drive is Copy Manager and Source of the Copy data to another SCSI device.

The drive in addition offers a wide range of support during the Copy command for SCSI devices that support the various levels of REV 17B of SCSI. The drive can Copy to or from devices that due not support disconnect/reconnect, messages, Extended Sense Format etc. Of course the drive is in its optimum environment when sharing the SCSI bus with other devices that support a high level of the SCSI protocol. When using the Copy command to do file by file operations there must be one copy command per file.

Parameter List Length - The Parameter List Length field informs the drive how many Parameter bytes to request following the transfer of the Copy CDB. The format for the Copy Parameter list has two components. They are the Parameter List Header and the Segment Descriptors. Their formats are as follows:

COPY COMMAND PARAMETER LIST HEADER FORMAT

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	COPY FUNCTION CODE					0	0	0
byte 1	0	0	0	0	0	0	FLL	DSC
byte 2	0	0	0	0	0	0	0	0
byte 3	0	0	0	0	0	0	0	0

COPY COMMAND DESCRIPTOR BLOCK FORMAT FOR SEQUENTIAL AND DIRECT ACCESS DEVICES

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	SOURCE SCSI ID			0	0	SOURCE LUN		
byte 1	DEST. SCSI ID			0	0	DEST. LUN		
byte 2	SEQUENTIAL ACCESS DEVICE BLOCK LENGTH (MSB)							
byte 3	SEQUENTIAL ACCESS DEVICE BLOCK LENGTH (LSB)							
byte 4	DIRECT ACCESS DEVICE NUMBER OF BLOCKS (MSB)							
byte 5	DIRECT ACCESS DEVICE NUMBER OF BLOCKS							
byte 6	DIRECT ACCESS DEVICE NUMBER OF BLOCKS							
byte 7	DIRECT ACCESS DEVICE NUMBER OF BLOCKS (LSB)							
byte 8	DIRECT ACCESS DEVICE LOGICAL BLOCK ADDRESS MSB							
byte 9	DIRECT ACCESS DEVICE LOGICAL BLOCK ADDRESS							
byte 10	DIRECT ACCESS DEVICE LOGICAL BLOCK ADDRESS							
byte 11	DIRECT ACCESS DEVICE LOGICAL BLOCK ADDRESS LSB							

COPY COMMAND SEGMENT DESCRIPTOR BLOCK FORMAT FOR SEQUENTIAL TO SEQUENTIAL ACCESS DEVICES

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	SOURCE SCSI ID			0	0	SOURCE LUN		
byte 1	DEST. SCSI ID			0	0	DEST. LUN		
byte 2	0	0	0	0	0	0	0	0
byte 3	0	0	0	0	0	0	0	0
byte 4	SOURCE BLOCK LENGTH (MSB)							
byte 5	SOURCE BLOCK LENGTH (LSB)							
byte 6	DESTINATION BLOCK LENGTH (MSB)							
byte 7	DESTINATION BLOCK LENGTH (LSB)							
byte 8	SOURCE NUMBER OF BLOCKS (MSB)							
byte 9	SOURCE NUMBER OF BLOCKS							
byte 10	SOURCE NUMBER OF BLOCKS							
byte 11	SOURCE NUMBER OF BLOCKS (LSB)							

Copy Function Code - The Copy Function Code tells the drive what type device it will be copying from or to. The Copy Function Codes that are supported by the drive are defined as follows:

00H - This code indicates that the Copy is from a direct access device to sequential device.

01H - This code indicates that the Copy is from a sequential device to a direct access device.

03H - This code indicates that the Copy will be from a sequential to a sequential access device.

Fill (FLL) - The FLL bit tells the drive if it should Fill or PAD the data to a 512 byte boundary should the current Copy command fail to do so. An example would be where the drive is instructed to copy three 256 byte sectors from a disk type of device. If this field is set a one the drive will automatically halt after transferring the 768 (3 X 256) from the source device and fill the remaining 256 byte locations in the drive buffer with zeros before fixing the two blocks to tape. This function is done on the Segment Descriptor Block level. If the FLL bit is zero the drive will perform the fill operation after the last Segment descriptor block Copy function is completed.

NOTE

It will be the systems responsibility to strip these pad character from the data when read back from the drive. The drive works on a 512 byte block boundary and will not automatically strip the pad off when the data is read later.

Disconnect (DSC) - If this bit is set to one, the drive will not allow the other SCSI device to disconnect from the drive until the Copy command has completed. This function is accomplished by the same means an Initiator can disable the drive disconnect feature, the Identify Message.

Source SCSI ID - This tells the drive what SCSI ID the Copy data is coming from.

Source LUN - This field tells the drive which LUN on the previously identified SCSI device the Copy data is from.

DEST. SCSI ID - This field tells the drive which SCSI device the Copy data is to go to.

DEST. LUN - This field tells the drive which LUN of the previously identified SCSI device the Copy data will be "FIXED" on.

Sequential Access Device Block Length - This field tells the drive what block size it will be dealing with.

Direct Access Device Number of Blocks - This field tells the drive how many blocks will be involved in the Copy command.

Direct Access Device Logical Block Address - This field is used to select the correct starting Block Address on the direct access device for the Copy command.

Source Block Length - This field tells the drive the size of block that will be coming from the source device. If the drive is the source device this field must be set to 0200H.

Destination Block Length - This field tells the drive the size of block that the copy data will be written to. If the drive is the destination device this field must be set to 0200H.

Source Number of Blocks - This field tells the drive how many blocks will be copied in a sequential to sequential device operation.

SPACE COMMAND (11H)

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	0	0	0	0	0
byte 1	0	0	0	0	0	0	CODE FIELD	
byte 2	COUNT (MSB)							
byte 3	COUNT							
byte 4	COUNT (LSB)							
byte 5	0	0	0	0	0	0	FLG	LNK

The Space CDB, shown above, provides a variety of tape positioning functions which are determined by the Code Field and Count Bytes in the SPACE command CDB. Only forward spacing is allowed.

If the disconnect function is enabled, the drive may disconnect from the Initiator while executing this command.

Code Field - The code field bits determine the tape positioning function to be executed. The codes are listed and described below.

Space Command Code Field Bits

BITS 01	00	DESCRIPTION
0	0	Data Blocks
0	1	File Mark Blocks
1	0	Sequential File Mark Blocks
1	1	Physical End-Of-Data

If a file mark is encountered during execution of Space command that is spacing over data blocks, tape movement is stopped, with the media position placed after the file mark block. The drive sends a Check Condition status code to the Initiator and sets the FM and AVF bits in the Extended Sense Bytes to 1. The

Sense Information Bytes of the Extended Sense Bytes contain the number of data blocks not spaced over; the drive sets the Sense Key to No Sense and the Sense Code to File Mark. The tape is positioned after the file mark.

NOTE

If a recoverable error occurs on a file mark block, the drive returns a Sense Key that only reflects that a filemark was detected.

When spacing over file mark blocks, the Count field specifies the number of file mark blocks required before stopping. If an end-of-media condition is encountered while spacing, the drive Controller sets the AVF bit in Extended Sense Byte to 1, and sets the Blank Check sense key code. The Information Bytes of the Extended Sense contain the number of file mark blocks not spaced over.

When spacing over Sequential file mark blocks, the Count bytes specify the number of consecutive file mark blocks required before stopping. The tape is positioned after the last file mark block of the sequence. If a data block is encountered during a space operation, the count is reset to its initial value and the space operation begins again with the media positioned after the data block. If a logical end-of-media condition is encountered (which indicates a lack of data on a tape cartridge) during a space operation, the drive sends a Check Condition status code to the Initiator and sets the AVF bit in the Extended Sense Byte to 1. The drive sets a Blank Check error code in the Extended Sense. The Sense Information Bytes of the Extended Sense Bytes then contain the original specified number of file mark blocks.

When spacing to the physical end-of-data, the drive ignores the Count field. Forward tape motion occurs until a blank tape region is detected, whereupon the tape is repositioned to allow future Write command operations to append data to the tape.

Count Bytes - Only positive values are allowed in the Count Bytes (Bytes 02 through 04). A negative number (2's complement) results in a Check Condition status code and an Illegal Request Sense Key message in the Extended Sense Bytes. A zero value causes no tape motion.

ERASE COMMAND (19H)

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	1	1	0	0	1
byte 1	0	0	0	0	0	0	0	1
byte 2	0	0	0	0	0	0	0	0
byte 3	0	0	0	0	0	0	0	0
byte 4	0	0	0	0	0	0	0	0
byte 5	0	0	0	0	0	0	FLG	LNK

The Erase CDB, shown above, causes the entire media cartridge to be erased. The SCSI standard specifies that only a portion of the tape be erased; however, the drive erases the entire tape. Failure to set the Long bit (byte 01, bit 00) to logic 1 results in an error condition.

If the disconnect function is enabled, the drive may disconnect from the Initiator while executing this command.

REWIND COMMAND (01H)

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	0	0	0	0	1
byte 1	0	0	0	0	0	0	0	0
byte 2	0	0	0	0	0	0	0	0
byte 3	0	0	0	0	0	0	0	0
byte 4	0	0	0	0	0	0	0	0
byte 5	0	0	0	0	0	0	FLG	LNK

The Rewind CDB, shown above, causes the selected tape drive to perform a rewind to the physical beginning-of-tape (BOT) or load point. If the disconnect function is enabled, the drive may disconnect from the Initiator while executing this command.

RECOVER BUFFERED DATA COMMAND (14H)

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	1	0	1	0	0
byte 1	0	0	0	0	0	0	0	FBM
byte 2	NUMBER OF BLOCKS (MSB)							
byte 3	NUMBER OF BLOCKS							
byte 4	NUMBER OF BLOCKS (LSB)							
byte 5	0	0	0	0	0	0	FLG	LNK

The Recover Buffered Data CDB, causes recover of data that has been written to the data buffer in the drive which has not yet been written to tape. Usually, this command is used only to recover from error or exception conditions that prevent writing the buffered data to tape.

This command function is similar to the Read command function, except the data is transferred from the drive data buffer instead of from tape. The order in which data blocks are transferred is the same as they would have been transferred to the tape.

This command should be used only in response to a Volume Overflow Sense Key Error code in the Extended Sense Bytes.

If an attempt is made to the read more blocks than are contained in the buffer, the drive sends a Check Condition status code. It also issues the Blank Check Sense Key and sets the AVF bit in the Extended Sense Bytes to 1. The Sense Information Bytes contain the number of blocks that could not be transferred.

If the disconnect function is enabled, the drive may disconnect from the Initiator while executing this command.

Fixed Block Mode (FBM) - This bit must be set to 1.

Number of Blocks - Bytes 02 to 04 - These bytes specify the number of blocks of data to be transferred from the data buffer in the drive to the Initiator.

SEND DIAGNOSTIC COMMAND (1DH)

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
byte 0	0	0	0	1	1	1	0	1
byte 1	0	0	0	0	0	ST	0	0
byte 2	0	0	0	0	0	0	0	0
byte 3	0	0	0	0	0	0	0	0
byte 4	0	0	0	0	0	0	0	0
byte 5	0	0	0	0	0	0	FLG	LNK

The Send Diagnostic CDB, show above, causes a diagnostic function code to be sent to the drive. The only diagnostic function supported is self-test.

Self-Test (ST) - If the ST is set to 1, the drive is directed to complete its default self-test diagnostic routine.

SECTION 3

HARDWARE CONFIGURATION

HARDWARE CONFIGURATION OPTIONS

The user Hardware Configuralbe Options of the drive are broken into three groups. They are:

1) SCSI ID Selection

2) Bus Parity Option

3) Bus Termination Power Option

4) SCSI Bus Terminator packs

5) Hard/Soft Reset Jumper (JP5)

All user Configurable Options must be set/installed while the drive is in "Power-Off" condition.

1) SCSI ID Selection - The SCSI ID for the drive is set through the DIP Switch package. The following table outlines the SW1, SW2 and SW3 settings within the dip switch pack involved with SCSI ID selection.

NOTE

ON or CLOSED are logical equivalents.
OFF or OPEN are logical equivalents.

SW1	SW2	SW3	SCSI ID
OFF	OFF	OFF	ID 0
ON	OFF	OFF	ID 1
OFF	ON	OFF	ID 2
ON	ON	OFF	ID 3
OFF	OFF	ON	ID 4
ON	OFF	ON	ID 5
OFF	ON	ON	ID 6
ON	ON	ON	ID 7

2) Bus Parity Option - The Bus Parity Option is enabled by SW8 of the dip switch pack.

SW8 = ON = Bus Parity Option Enabled
SW8 = OFF = Bus Parity Option Disabled

3) Bus Termination Power Option - JP1 (Jumper 1) is the means by which one can select the power source for the two bus Terminator resistor packs (RP1 & RP2) on the drive. When JP1 is installed the drive will supply the Terminator resistor power to pin 26 of the SCSI bus. The drive is back flow power protected through the use of an isolation diode. If the voltage on the bus with JP1 installed is greater than that supplied by the drive, than the bus will supply the power for the bus terminators. If the drive voltage is greater than the bus voltage, the drive will supply the bus Terminator power. With JP1 removed, the Bus Terminator Power must come from pin 26 of the SCSI bus. The default is JP1 installed.

4) SCSI Bus Terminator Packs - The drive comes with two 220/330 resistor packs installed at board locations RP1 and RP3. If the drive is not the last device on the bus, these packs must be removed.

5) Hard/Soft Reset Jumper (JP5) - The JP5 jumper installed (as shipped) causes the drive to perform a Hard Reset (power up type reset) when the Reset signal is asserted on the SCSI bus. With JP5 removed the drive will do a Soft reset removing itself from the bus and bringing an orderly halt to any operation it may be executing.

Factory Set Hardware Configuration

The following jumpers and switches are used as part of Cipher's Manufacturing process. Changing there values in the field will cause catastrophic failure of the drive. They are for Cipher use only. The factory setting list below is intended for check purposes only! If they do not match, set to values indicated before power is applied.

JP3 - INSTALLED

FACTORY SET SWITCH PACK SETTINGS

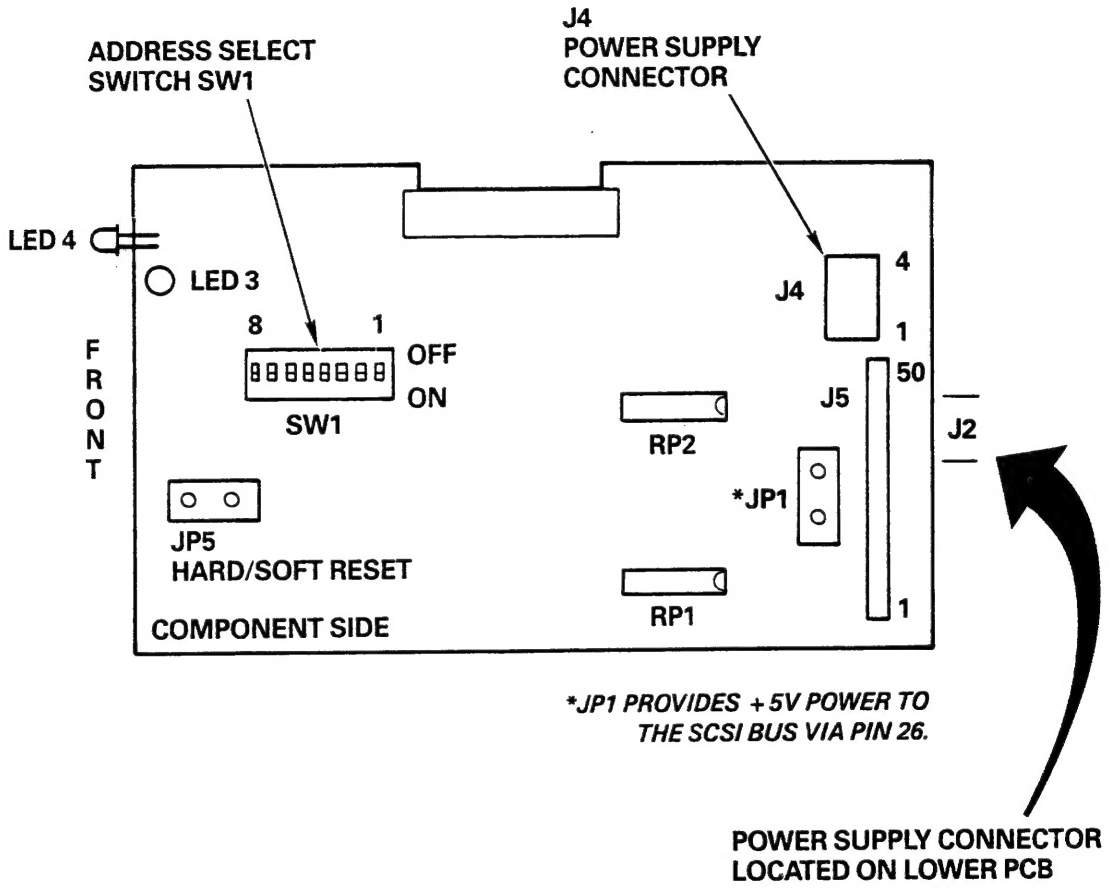
SW7 - OFF
SW6 - OFF
SW5 - OFF

The board layout drawing on the next page will help in locating these components.

J4 - is an alternate power connector used during the manufacturing process only. The drive must be powered from the power connector on the lower board (Basic Drive Board). The top board of the drive derives its power from the lower board.

LED 3 - represents the status of the drive. As long as the led is flashing the drive is in the "Running" mode. If LED 3 remains either on or off, the drive is "Hung". The drive must receive a Reset pulse from the SCSI bus to clear this condition.

LED 4 - LED 4 when off indicates to the user that the cartridge is in a "Safe To Remove" state. When LED 4 is on, the cartridge is in an "Unsafe To Remove" state. There several software ways in which to turn the led on and off. They are covered in Section 2 by the Load/Unload, Prevent/Allow Media Removal and Mode Select commands.



SECTION 4

SPECIFICATIONS

INTRODUCTION

The applicable specifications have been ascertained using a cartridge certified by Cipher in a drive with a formatter PCB.

In the specifications for errors, it is understood that a recoverable error is one that can be overcome in no more than 16 retries.

DATA HANDLING	
Transfer Rates	
90 ips streaming	86.7 KBytes/sec
Maximum Burst	1.3 MBytes/sec
Data Buffering	32 X 512 bytes
Capacity (formatted)	
450 ft Cartridge	45 mb
555 ft Cartridge	55 mb
600 ft Cartridge	60 mb
Recording Tracks	9
Density	8,000 bpi
Recording Code	(0,2) Run Length Limited
Head Type	2-channel Read-After-Write with full width AC Erase Bar
Maximum Error Rate:*	
Soft Write	1×10^{7}
Soft Read	1×10^{8}
Hard Read	1×10^{10}
Mean Time Between Failures	18,000 hrs with 20% workload

*Soft errors recoverable in 16, or fewer, tries.

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